DOCUMENT RESUME

ED 449 037 SE 064 502

AUTHOR Park, Hyun-Ju; Choi, Byung-Soon
TITLE Korean High School Students' Views about Learning and Knowing Science.
PUB DATE 2000-04-00
NOTE 23p.; Paper presented at the Annual Meeting of the National Association for Research in Science Teaching (New Orleans, LA, April 28-May 1, 2000). "The research reported in this article was made possible largely through grant from Brain of Korea 21 Project."
PUB TYPE Reports - Research (143) -- Speeches/Meeting Papers (150)
EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS *Concept Formation; *Epistemology; Foreign Countries; High School Students; High Schools; *Learning; Science Education; *Student Motivation
IDENTIFIERS *Conceptual Change; South Korea

ABSTRACT

While previous studies have recognized and have researched the resistance of students' scientific conception to change and the difficulty of the change of the conception's status, few have investigated the idea of conceptual ecology as the affective and motivational aspects might play when students are exposed to conceptual change learning. The present study was conducted to describe in detail Korean students' view about learning and knowing science with students' conceptual ecologies. The study was interpretive, using multiple data sources to achieve a triangulation of data. Three students from a public high school for boys serve as cases representative of Korea students' views of learning and knowing science. Students' enthusiasm to pursue science was closely connected to their views about learning and knowing science. Students' views about learning and knowing science are influenced by their views regarding science and science class including the nature of knowledge, learning, and their epistemological commitments. They influence students' self-efficacy and motivation on learning science. (Contains 34 references.) (Author/ASK)

Reproductions supplied by EDRS are the best that can be made
from the original document.

ED 449 037

Korean High School Students' Views about Learning and Knowing Science*

Hyun-Ju Park & Byung-Soon Choi

Korea National University of Education
Department of Chemistry Education
Kangnae-myun, Chongwon-gun
Chungbuk 363-791
Korea, Republic of

H. Park

U.S. DEPARTMENT OF EDUCATION
Office of Educational Research and Improvement
EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)
This document has been reproduced as received from the person or organization originating it.
Minor changes have been made to improve reproduction quality.
Points of view or opinions stated in this document do not necessarily represent official OERI position or policy.

Correspondence to Hyun-Ju Park: hpark4@chollian.net

Paper presented at the annual meeting of the National Association for Research in Science Teaching in New Orleans, LA, April 28 - May 1, 2000.

*The research reported in this article was made possible largely through grant from Brain of Korea 21 Project. Any opinions, findings, or conclusions are those of the authors and do not necessarily reflect views of the supporting agency.

BEST COPY AVAILABLE

ABSTRACT

While previous studies have recognized and have researched the resistance of students' scientific conception to change and the difficulty of the change of the conception's status, few have investigated the idea of conceptual ecology as the affective and motivational aspects might play when students are exposed to conceptual change learning. The present study was conducted to describe in detail Korean students' view about learning and knowing science with students' conceptual ecologies. The study was interpretive, using multiple data sources to achieve a triangulation of data. Three students from a public high school for boys serve as cases representative of Korea students' views of learning and knowing science. Students' enthusiasm to pursue science was closely connected to their views about learning and knowing science. Students' views about learning and knowing science are influenced by their views regarding science and science class including the nature of knowledge, learning, and their epistemological commitments. They influence students' self-efficacy and motivation on learning science.

Introduction

The purpose of this study

The science education literature of the 1980s and 1990s includes numerous studies of students' conceptions about scientific phenomena. From these research, students' conceptions are often differ from that of scientists(Driver & Erickson, 1983; Driver, Guesne, & Tiberghien, 1985; Garnett, Garnett, & Hackling, 1995; Osborne & Freyberg, 1985; Pine & West, 1986). As well, students' conceptions may be highly resistance to change(Driver et al., 1985; Novak, 1988; Osborne & Freyberg, 1985; Strike & Posner, 1985). The theory of Conceptual Change Learning(CCM) was proposed by Posner, Strike, Hewson, & Getzog(1982), in order to make these students' conception to scientific conceptions.

The theory of Conceptual Change became the leading paradigm that guided research and instructional practices in the science education community for many years. However, it also became subject to a number of criticisms. One specific criticism of the CCM is that it focuses only on the supposed underlying logical structures and a rational process, and lacks attention to affective aspects as well as motivational constructs in students' learning science(Demasters et al.,

1995; Pintrich, Max, & Boyle, 1993; Strike & Posner, 1992; Vosniadou & Ioannides, 1998).

We believe, however, that the criticism should not be directed at the theory of CCM. CCM have begun with an analogy of student learning to a way in which many contemporary interpretation in history and philosophy of science knowledge have changed in the scientific community. When CCM is proposed, there are two important factors that can help students experience conceptual change: status of conception and conceptual ecology. The idea of status of students' conception is represented the view of CCM on student learning as a rational process; Conceptual ecology provides the context of conceptual change learning to influence the status of conceptions as intelligibility, plausibility, fruitfulness, and dissatisfaction. As Toulmin(1972) stated, the degree of the status of conception within conceptual ecology affect the influence of intellectual selection. And the development of one's intellectual disciplines creates a diversity of approaches limited only by the selective influence of active conceptual problems. Conceptual ecology contains the history of affective aspects and motivational constructs as well as the development of metaconceptual awareness and the construction of theoretical frameworks with greater systematically, coherence, and explanatory power.

While previous studies have recognized and have researched the resistance of students' scientific conception to change and the difficulty of the change in conception's status, few have investigated the idea of conceptual ecology as a context of conceptual change learning, such as affective and motivational aspects might play when students are exposed to conceptual change learning.

Many studies on students' learning science have demonstrated that students have 'a traditional' view of learning and knowing and the views fluence their learning science. The purpose of this study is to investigate Korean students' views about learning and knowing science by analysing students' conceptual ecologies. The result of this study will help us expand our understanding students' views on learning and knowing science and their influences on students' learning science as a motivational aspect.

Definitions

Conception

Conceptions are mental representations that allow individuals to understand, explain, predict, and/or interpret an event or system. Conceptions are objects of thought as well as the tools of thought, and function as perceptual categories(Driver, 1989; Driver & Erickson, 1983; Hashweh, 1986; Hewson & Posner, 1984; Linder, 1993; Strike & Posner, 1992). Conceptions are the structure of units of information and the ways in which they are linked together and used(Hewson & Hewson, 1983). Conceptions provide explanatory and predictive power(Hewson, 1988), and include affective aspects of individual.

Conceptual change

The process of conceptual change appears to be a gradual and complex affair during which information and/or data that comes in through observation and/or instruction is used to enrich (conceptual capture), reorganize or restructure (conceptual restructuring), and replace or exchange (conceptual exchanging) existing beliefs and presuppositions as well as conceptions.

Conceptual ecology

The CCM has been expanded by the idea of Toulmin(1972)'s conceptual ecology. The notion of conceptual ecology provides a context for understanding individual's conceptual change learning, as it is the intellectual environment in which all information or data is interpreted. Conceptual ecology helps individuals to find the deeper structures and commonalities in the world, which then allow them to reason causally about the observations they make, and to create knowledge which incorporates and change conceptions. Thus, there may be different conceptions to be evolved on the same natural phenomenon because of differences on conceptual ecology: historically and culturally.

Conceptual ecology influences and facilitates the way new conceptions fit into a given conceptual ecology(Beeth, 1993; Demastes, Good, & Peebles, 1995; Hewson, Beeth, & Thorley, 1994; Strike & Posner, 1992; Thorley, 1990), deciding the status of conception of dissatisfaction, intelligibility, plausibility, and

fruitfulness. Conceptions exist as a part of conceptual ecology, not independently. Student's conceptions are the results of interaction with nature, and formed throughout self-regulated and under unconscious conditions within conceptual ecology. Conceptions resist to change. The reason of resistance of one's conceptions may be because conceptions are interrelated weblike with other components of conceptual ecology. In order for a student to experience conceptual change, we have to understand a student's conception with conceptual ecology: how one's conception is generated and retained.

Research Methods

We made use of an interpretative research design based on principles of naturalistic inquiry(Erickson, 1986; Lincoln & Guba, 1985). We sought to come to understand and share the meaning constructions of students learning and knowing science(Erlandson, Harris, Skipper, & Allen, 1993). A key features of our analytical procedures was constant comparative analysis(Strauss, 1987) which we applied to the texts generated from the various data sources. Our intention was to develop exemplary cases for students' views about learning and knowing science. Triangulations on data collection and analyzing were implemented(Denzin, 1970; Mathison, 1988)

The Students and School. The study was conducted at a high school in Seoul metropolitan area in Korea. The school has their own entrance examination for an admission to the school, and is only for those students who wish to enter universities. About top 10% of whole middle school students in the area can get the admission to the school. The average score of the National Entrance Exam of students in this school is 350 which is 9 percentile.

The participants in the study were six sophomore students. The students were accidentally selected by their science teacher. They caught the teacher's eyes when they stayed and cleaned their classroom after school. However, fortunately they did have volunteerism in all aspects of data collections and

good attendance patterns. The students took Physics, Chemistry and Biology during the study period. They do have experimental activities twice per semester as a part of exams, the middle of and the end of semester.

Data Collection. Data was collected by several sources for triangulation from June 1998 to February 1999: Interviews(Bogdan & Biklen, 1992; Lincoln & Guba, 1985), observations (Bogdan, 1973), and documents(Krippendorff, 1980)

Interviews Six interviews were conducted per student, and every interview was succeeded by a follow-up interview to clarify concerns or questions that had arisen in the previous interview or in students' observation of their science classes. Students were asked to answer questions and then told to the interviewer the reason why. Interviews took place in the school library and audio recorded. The topics dealt with in the interviews were: students' lives and science; understanding the nature of science; concept of acid and base; science class and teacher; science activities; and some concerns from students' observational journals of science classes.

Observations The teachers did not allow us to observe their science classes. Therefore, the students were asked to observe their science classes and to report their observations, for six to eight weeks starting from the second week of October 1998. They had written about their science classes: when the class started and finished, how the classroom went, what and how the science teacher taught, what they felt and thought, what and how students were doing, etc. Five students reported their observations, but one student was told to forget about class-observation. One student observed his classes and made reports on that. However, he lost his reports and made a copy of his friends' science notebook.

Documents The documents for this research included: research notebooks, students' notebooks, and a profile of the students written by their science teachers, GALT tests and exams, as well.

Data Analysis. This study is primarily descriptive in nature. Thus, interpretive methods of data analysis were employed(Erickson, 1986; Miles & Huberman, 1994; Strauss, 1987). The transcripts of interviews were examined

with an eye toward students' views about learning and knowing science. We reviewed the full set of interview notes and audiotapes, as well as documents and students' journals of science class observations. We transcribed audio recordings for interviews and coded segments of the transcript according to the identification of conceptual ecology. Students' reports of their science classes were coded as analysis of components of conceptual ecologies.

In order to see students' views about learning and knowing science reflected in conceptual ecologies, we have began with Park(1995)'s components of conceptual ecologies, such as their views on science, their epistemological commitments, and the nature of learner, etc. As we have analyzed cases, we found there were relationships among and between selected components of conceptual ecology, and these might fluence students' motivation of learning science.

Three science teachers who have been studying as doctoral students in the field of science education were asked to analyze and to report of the data. All three concurred with our interpretation of the three cases: Kangsan, Suin, and Minne.

Results and Discussions

There are different aspects of students' motivation based on different ecologies. Three students who are considered representing three aspects of motivation: Kangsan(Table 1), the helplessness learner; Suin(Table 2), the safty learner; and Minne(Table 3), the constructed learner.

1. I don't know [science] by nature: the case of Kangsan

Kangsan always started with *"I don't know"* when he had a question posed by researchers or by teachers, and added *"I don't know by nature."* However, he usually knew what was the problem and had a right answer.

Kangsan defines science that it is opposed to instinct, and is an objective

and logical discipline, which makes things possible to be either true or false. He said, there is repeating experiments in order to constitute scientific theory. He was interested in the area of science, but he said that it was a waste of time to try to solve his curiosity because his curiosity or interest did not help him to get a good score on exams.

According to Kangsan, science textbooks or teachers posses the right scientific knowledge, *"the correct theory,"* and the right answer. Students, therefore, must accept whatever proposed by textbooks or teachers without critic, as *"it doesn't need to think about it"* because knowledge in a textbook represents the truth. Kangsan's epistemological commitment relied on knowledge in a textbook or of a teacher.

Kangsan believes that a teacher has to lead students to study, and a student has to understand what a teacher is presenting. What a student cannot understand has to be memorized for exams. Kangsan preferred a kind of relaxed classroom environment where a teacher and students have a relationship and feel for each others. However, a teacher has to go into students, not vice versa.

Kangsan's report of science class observations included date, time, content, and features of class. Many detailed contents were appeared on the report, and it seemed he made full copies of every things on blackboard written by a teacher. According to Kangsan, *"students must listen when a teacher teaches."*

The case of Kangsan seemed to be an example of, so called, 'learned helplessness.' That is, he believed he could not perform anything in science subject successfully because he was not smart enough to study science. This makes him a student of passive disposition in his science learning and knowing. He denied the importance of reflective thinking when he learned. He felt self-confidence when he found his experience or logic was the same as knowledge in a textbook or of a teacher. Even when succeeded, he tended to deny that it was him who solved the problem. Kangsan attributed the success to uncontrolled variable, he could solve it because he had a good luck like the easiness of the task, a teacher's help or *"by an accident"*

2. I study this because it will be on exams: the case of Suin.

Suin's twin brother entered a high school that is one level higher by scores of an entrance exam than that of Suin's high school. He seemed to be introspective and speaks fast with low voice. He seemed to be hard to get acquainted with many friends. He follows well what his teacher said and demanded.

Suin studied in order to get good scores to enter universities. He guessed what will be on the exams, organized his notes based on his guess, and studied that. He reviewed the lesson, memorized things to be remembered, and prepared for exams accordingly. He almost didn't read any other references except the text or text-reference. To Suin, if any knowledge that is not on a text, it means that it doesn't necessarily need to be learned. Suin said, *"I study only the text, and memorize formulas... thinking it doesn't do me any good..."* and added *"I will learn the other knowledge later and will satisfy my curiosity and interests after I enter a university."*

Suin defined science as *"daily life,"* because we use many scientific instruments, such as T.V., computer, video, etc. According to Suin, science is objective knowledge that can be proved and is possible by experiments. Therefore, it is not science if it cannot be proven because we can't experience it. Suin said, the scientific method is, as his teacher said, to design an experiment by developing a hypothesis, and follow it.

The way Suin justified his reasoning when he interviewed about his belief that a piece of knowledge is true upon the power of science teachers or a text. A text is a set of facts. As a preceding learner, a teacher must transmit the knowledge to students. A student doesn't need to think the knowledge because it belongs to profession, such as scientists or teachers. Therefore, he rather memorized than to understand the scientific concepts. He did not confirm his logic and knowledge because he didn't feel it to be needed.

According to Suin, a student will learn well when a teacher explains a scientific concept in detail. A teacher transmits contents correctly and students must learn in order to get a high score on exams, even though

rote-memorization. Suin said that *"an emotional stability"* was important in learning science. That is, an amity between a teacher and student influences a science class. He told that, however, two weeks before an exam is the best time to concentrate in studying science class. This shows that Suin seems to be motivated not by emotional stability but by an exams.

Suin's self-efficacy was low. He believed that he could not study science well because his IQ is low. Even though he felt uneasy, he always studied what he had to because of getting good scores on exams. The reason he studied is to do well on exams and to enter a university. He argued that high school was needed for students to prepare for entering university, and Suin would learn *"real knowledge"* after he enters a university. That is, it doesn't matter whether he understands a scientific concept, sees plausibility of it, and/or can use it or not if he can get a good scores on exam even by way of memorization.

Suin handed in his observation of science classes. He told us, he lost his observation report so he made a copy from one of his friends' notes. To Suin, asking to report science classes was another task he has to do for a teacher.

Suin seemed to not have any adventure on learning and knowing science. He wanted to go a university because everyone seems to feel 'should go', and he didn't want to be treated distantly by others. He tended to study the safe test way to get good scores on exams. He, therefore, focused on studying what the teacher pointed out or what is expected on exams. That is, learning science is only a means of getting a good score to enter a university, but there is not any value on learning science itself. Learning science is to memorize a scientific concept presented by a teacher or in a text, but it is not to change Suin's conception of the scientific concept.

3. I study for interests, and for getting a good score on exam as well: the case of Minne

Minne wanted to be an oriental medical doctor. According to his teacher, he was diligent, had never done another business during science class, and had a strong will to learn. He had a very good scores on every subject. Scores of

science was excellent too. That is because he had a good judgement and was a hard worker. However, most of his teacher was disappointed on him because they thought Minne's score would be higher than he actually got. A teacher said that he studied hard enough to get the highest score on exams, but he didn't.

Minne introduced himself as one who had many interests on science. He told that he had tried to read many books about both oriental and western views on the philosophy of science, for example, the structure of scientific revolution(Written by Kuhn, translated into Korean 1987), science and value(Written by Laudan, translated into Korean 1994). He believed that it should be needed for him to be an oriental medical doctor.

Science defined as a discipline that can include everything. Minne argued, "*...any thing in the world... any phenomena has potential to be a science,*" because "*...things that completely unknown in present... for example, spirit... if any scientist is interested in it or if there is social needs on it... [spirit] will be studied, and then such spirit might be categorized as an area of science.*" He classified physics as a radical conceptual change, such as Newtonian to Einstein whereas chemistry, as a weak conceptual change, such a small changes on the model of atoms. According to him, scientific methods for that are various, example of experiment, induction, deduction, reasoning, etc.

The way he justified his reasoning when he interviewed and his belief that a piece of knowledge is true relied upon his knowledge, logic, and judgement. However, if there was a discrepancy between his teacher and he, he would try to remember what the teacher said and his judgement was deferred in the school context, such as if he found the discrepancy on an exam where he solved a problem by his experience and judgement out of school context. Minne was not sure about the school knowledge whether it is true, because it is hard to get a big picture of scientific world.

Minne said that a teacher must have enough professional content knowledge with eagerness to teach, and a student should have one's own intellectual interest or curiosity on knowledge. Moreover, a student must care about one's

achievement because a student's position is to enter a university. Minnie had a negative aspect of educational environments, such as focusing only on preparing for the Exam in science class. However, he seemed to do his best and to act positively, as a student.

Minne was a kind of student who often asks questions. He tried not to ask questions because that made his teacher and other friends embarrassed. Sometimes, it was because his questions was not related to the day's lesson. Sometimes, it was because his questions deepen to much, like college level. Therefore, Minne said that he tried to solve a problem by himself. Minne felt the limitation of high school curriculum. According to him, a science text presents a piece of knowledge as same as dictionary. To him, it was hard to understand contents as whole in science because a scientific theory in a text didn't provide a context to understand or because a text showed only superficial knowledge.

Minne usually studied during a recess of 10 minutes because he knew the importance of taking advantage of time in learning. He enjoyed learning science by himself. He liked the way he understood and thought. He said that, however, he tried not to think deep when he takes exams, because he could make mistakes when he think too deep on questions. According to Minne, an exam in school is for grading students. It was not to construct knowledge but to check what a student already knows. So, *"anomaly was ignored in science classes"*.

Minne's observational report included date, time, content, behaviors of students and a teacher during each class, and how he felt in detail as if we were watching a T.V. drama: What and why a teacher brought for his lesson, how students dealt with, why student felt bored, and why the content was in the curriculum... etc.

Minne let his own learning goal of science to meet his intellectual interest as well as to succeed in entering a university. He seemed to deal learning science actively and positively. These made him to have a high self-efficacy. Minne also used metacognition strategy to learn and know science.

Kangsan and Suin had general tendency to have a belief in objectivist view, rationality, and absolute truth of scientific knowledge. They believed that scientific knowledge is only that which has been proven or confirmed by repeating experiments in order to constitute scientific theory. Scientific knowledge was presented by a teacher or on a text. Kangsan and Suin justified their knowledge and reasoning by a teacher or a text because a teacher or a text has correct theory to solve questions on exams. This is the key driving force to have a low self-efficacy and to make students as passive learner. In learning and knowing science, Kangsan and Suin seemed to see themselves as not the subjects but the objects. They accepted what a teacher presented without thinking of why or how. To them, it was 'what' they had studied. They told that they have never been expected to think, and they had thought so. In fact, they didn't the needs of thinking itself. They tend to see scientific knowledge can only be possessed by expertises, like scientist or teachers. In the case of Kangsan, he has never doubted about a scientific knowledge. Moreover, Kangsan believed he could not perform anything in science subject successfully because he was not smart enough to study science. This makes him a student of passive disposition in his science learning and knowing.

In the case of Suin, he seemed not to have any adventure on learning and knowing science. He tended to motivated by good scores on exams, and focused on studying what his teacher pointed out or what is expected on exams. To Suin, learning science is only a means of getting a good score to enter a university, but there is no value on learning science itself.

Minne had a view close to constructivism. He defined that any thing in the world has potential to be a science because of dynamic aspects of science knowledge. He let his own learning goal of science to meet his intellectual interest as well as to succeed in enter a university. He seemed to deal learning science actively and positively. These made to him have a high self-efficacy. Minne also used metacognition strategy to learn and know science.

Kangsan, Suin, and Minnie distinguished necessary knowledge from unnecessary knowledge on the basis of individual motivational dispositions like

extrinsic/intrinsic authority of scientific knowledge, individual learning goals, and self-efficacy. Their enthusiasm to pursue science was closely connected to their views in regards to the nature of knowledge, the nature of learning, and their epistemological commitments. Kangsan's and Suin's views about learning and knowing science discouraged them from delving deeper into scientific phenomena on their own: Kangsan had a tendency to study only the things that has been presented by a teacher; whereas Suin studied to get good scores on exams to enter a university. Minne's epistemological commitments are consistent with his confidence. That is, Minne justified his reasoning based on his epistemological commitment because he had confidence in his ability and knowledge. Minne accepted authority only under specific conditions: On exam, Minne had to decide only one. When there were conflicts between his beliefs and the teacher's explanation, he resolved the situation by relying on his epistemological clarity. Minne's self-confidence allowed him to determine when he would use his own explanation or when he would use his teacher's.

Conclusions and Implications

This study was to investigate Korean students' views about learning and knowing science by analysing students' conceptual ecologies. Students' enthusiasm to pursue science was closely connected to their views about learning and knowing science. Students' views about learning and knowing science are influenced by their views regarding science and science class including the nature of knowledge, learning, and their epistemological commitments. They influence students' self-efficacy and motivation on learning science.

Those who, for exmaple, have a belief in an objectivist view, rationality, and absolute truth of scientific knowledge, have general tendency to be a passive learner. They had a traditional view of learning and expected a teacher to transmit scientific knowledge to them. Also, they tend to justified their knowledge and reasoning by a teacher or a text because a teacher or a text has

correct theory to solve questions on exams. This is the key driving force to have a low self-efficacy and to make students as passive learner. For example, these students' seemed to value more on copy of what a teacher wrote than to construct knowledge. So, most things they do during classes are copying.

We believe as students' change their views about learning and knowing science, it will help to improve their learning. This study has contributed to understand students by analysing their conceptual ecology. And the results of this study implies that there is a necessity to stress learners' voluntary psychological aspects for self-directed learning, and this must be a driving force to learners' own.

An After Note

Kangsan failed to enter a university and has been cramming to try again.

Suin succeeded in entering a university and is majoring engineer. He is happy for that.

Minne failed to enter a university even though he got scores of top 2 percentile out of 400,000 students on the National Exam. He wanted to enter only a medical school. Some students do not care about the majors and try to enter based on scores of the National Exam, but some are not. Minne strongly cares about the major and decided to cram and try again.

Table 1. Kangsan's view about learning and knowing science

		Kangsan
Science	definition	It is opposed to instinct, and is an objective and logical discipline, which makes things possible to be either true or false.
	scientific methods	It is repeating experiments in order to constitute scientific theory
	scientific knowledge	science textbooks or teachers posses the right scientific knowledge... the truth
	science & I	I am interested in the area of science, but... it was a waste of time to try to solve my curiosity because my curiosity or interest did not help me to get a good score on exams.
Epistemological commitment		His epistemological commitment relied on knowledge in a textbook or of a teacher.
Science class	role of a student	Students must listen when a teacher teaches. A student has to understand what a teacher is presenting. What a student cannot understand has to be memorized for exams.
	role of a teacher	A teacher has to lead students to study. Teachers posses the right scientific knowledge.
	text	Knowledge in a textbook represents the truth.
	science class & I	I preferred a kind of relaxed classroom environment where a teacher and students have a relationship and feel for each others. However, a teacher has to go into students, not vice versa.
Characteristics of science class observations		Science class observations included date, time, content, and features of class. Many detailed contents were appeared on the report, and it seemed he made full copies of every things on blackboard written by a teacher.
Self-efficacy		I am not smart enough to study science.
Learning motivation		He is a student of passive disposition in his science learning and knowing.

Table 2. Suin's view about learning and knowing science

		Suin
Science	definition	-Science is *"daily life."* -It is objective knowledge that can be proved. -It is not science if it cannot be proven because we can't experience it.
	scientific methods	-The scientific method is, as his teacher said, to design an experiment by developing a hypothesis, and follow it.
	scientific knowledge	-It is presented on a text.
	science & I	-Science is a suject. -I am studying to enter a university.
Epistemological commitment		-He believed that a piece of knowledge is true upon the power of science teachers or a text
Science class	role of a student	-A student doesn't need to think the knowledge because it belongs to profession. -A student will learn well when a teacher explains a scientific concept in detail. -Students must learn in order to get a high score on exams. -I rather memorized.
	role of a teacher	-A teacher must transmit the knowledge to students correctly.
	text	-A text is a set of facts -If any knowledge that is not on a text, it doesn't necessarily need to be learned.
	science class & I	-I will learn the other knowledge later and will satisfy my curiosity and interests after I enter a university. -An amity between a teacher and student influences a science class. -Two weeks before an exam is the best time to concentrate in studying science class.
Characteristics of science class observations		-He lost his observation report so he made a copy from one of his friends' notes.
Self-efficacy		-I could not study science well because my IQ is low.
Learning motivation		-He is motivated not by emotional stability but by an exams.

Table 3. Minne's view about learning and knowing science

		Minne
Science	definition	-Science is a discipline that can include everything. -Any phenomena has potential to be a science.
	scientific methods	-Scientific methods for that are various, example of experiment, induction, deduction, reasoning, etc.
	scientific knowledge	-Scientific knowledge is developed by any scientists' interests or social needs on it.
	science & I	-Science is a subject. -I am studying to enter a university.
Epistemological commitment		-A piece of knowledge is true relied upon his knowledge, logic, and judgement. -If there was a discrepancy between my teacher and I, I would try to remember what the teacher said and my judgement was deferred in the school context.
Science class	role of a student	-A student should have one's own intellectual interest or curiosity on knowledge. -A student must care about one's achievement because a student's position is to enter a university
	role of a teacher	-A teacher must have enough professional content knowledge with eagerness to teach.
	text	-A text presents a piece of knowledge as same as dictionary. -A scientific theory in a text didn't provide a context to understand. -A text showed only superficial knowledge.
	science class & I	-He had a negative aspect of educational environments, such as focusing only on preparing for the Exam in science class. -He does his best and acts positively, as a student. -He usually studied during a recess of 10 minutes because he knew the importance of taking advantage of time in learning. -Anomaly was ignored in science classes. -An exam in school is for grading students. It was not to construct knowledge but to check what a student already knows.

Characteristics of science class observations	-It included date, time, content, behaviors of students and a teacher during each class, and how he felt in detail as if we were watching a T.V. drama. -What and why a teacher brought for his lesson, how students dealt with, why student felt bored, and why the content was in the curriculum... etc.
Self-efficacy	-He deals learning science actively and positively. -He has a high self-efficacy. -He used metacognition strategy to learn and know science.
Learning motivation	-He has his own learning goal of science to meet his intellectual interest as well as to succeed in entering a university.
A remark	-He classified physics as a radical conceptual change, such as Newtonian to Einstein whereas chemistry, as a weak conceptual change, such a small changes on the model of atoms.

References

Beeth, M. E. (1993). Dynamic aspects of conceptual change instruction. Unpublished doctoral thesis. University of Wisconsin-Madison.

Bogdan, R. (1973). Participant observation: a methodology for human studies. Newbury Park, CA: Sage.

Bogdan, R. & Biklen, S. (1992). Qualitative research of education. Boston, MA: Allyn and Bacon.

Demasters, S. S., Good, R. G., & Peebles, P. (1995). Students' conceptual ecologies and the process of conceptual change in evolution. Science Education, 79: 637-666.

Denzin, N. K. (1970). The research act: A theoretical introduction to sociological methods.

Driver, R. (1989). Students' conceptions and the learning of science. International Journal of Science Education, 11, 481-490.

Driver, R. & Erickson, G. (1983). Theories-in-action: Some theoretical and empirical issues in the study of students' conceptual frameworks in science. Studies in Science Education, 10, 37-60.

Driver, R., Guesnes, E., & Tiberghien, A. (1985). Children's ideas in science. Philadelphia: Open University Press.

Erlandson, D. A., Harris, E. L., Skipper, B. L., & Allen, S. D. (1993). Doing naturalistic inquiry: A guide to methods. Newbury Park, CA: Sage.

Erickson, F. (1986). Qualitative methods in research on teaching. In M. Wittrock (Eds.), Handbook of research on teaching (2nd) (pp. 119-161). NY: Macmillan Publishing Company.

Garnett, P. J., Garnett, P. J., & Hackling, M. W. (1995). Students' alternative conceptions in chemistry: A review of research and implications for teaching and learning. Studies in Science Education, 25, 69-95.

Hashweh, M. Z. (1986). Toward an explanation of conceptual change. European Journal of Science Education, 8(3), 229-249.

Hewson, M. G. A' B. (1988). The role of intellectual environment in the origin of conceptions: An exploratory study. In L. H. T. West & Pines (Eds.), Cognitive structure and conceptual change (pp. 211-231). Orlando, FL: Academic Press.

Hewson, P. W., Beeth, M. E., & Thorley, N. R. (1998). Teaching for conceptual change. In K G. Tobin & B. J. Fraser (Eds.), International Handbook of Science Education. (pp. 199-218). Dordrecht, The Netherlands: Kluwer Academic Publishers.

Hewson, P. W., & Hewson, M. G. A' B. (1983). Effect of instruction using students' prior knowledge and conceptual change strategies on science learning. *Journal of Research in Science Teaching*, 20(8), 731-743.

Hewson, P. W., & Hewson, M. G. A' B. (1984). The role of conceptual conflict in conceptual change and the design of science instruction. *Instructional Science*, 13, 1-13.

Jones, M. G., Carter, G., & Rua, M. J. (2000). Exploring the development of conceptual ecologies: Communities of concepts related to convention and heat. Journal of Research in Science Teaching, 37(2), 139-159.

Krippendorff, K. (1980). Content analysis: an introduction to its methodology. Newbury Park: Sage.

Lincoln, Y. & Guba, E. (1985). Naturalistic inquiry. Bevery Hill, CA: Sage.

Linder, C. J. (1993). A challenge to conceptual change. Science Education, 77(3), 293-300.

Mathison, S. (1988). Why triangulate? Educational Researcher. 17(2), 13-17.

Miles, S. & Huberman. A. (1994). Qualitative data anaiysis. Newbury Park, CA: Sage.

Novak, J. (1987). Proceedings of the second internal seminar: Misconceptions in science and mathematics, Vol. I-III. Cornell University, Ithaca, NY.

Osborne, R. J. & Freyberg, P. (1985). Learning in science: The implication of children's science. Auckland, New Zealand: Heinemann.

Park, H. (1995). A study of the components of students' conceptual ecologies. Unpublished doctoral thesis. University of Wisconsin-Madison.

Pines, A. L., & West, L. H. T. (1986). Conceptual understanding and science learning: An interpretation of research within a source-of-knowledge framework. *Science Education*, 70(5), 583-604.

Pintrich, P. R., Max, W. M., & Boyle, R. A. (1993). Beyond cold conceptual change: the role of motivational beliefs and classroom contextual factors in the process of conceptual change. Review of Educational Research, 63: 167-199.

Posner, G. J., Strike, K. A., Hewson, P. W., & Gertzog, W. A. (1982). Accommodation of a scientific conception: Toward a theory of conceptual change. Science Educauon, 66: 211-227.

Strauss, A. (1987). Qualitative analysis for social scientist. New York: Cambridge University Press.

Strike, K. A. & Posner, G. J. (1985). A conceptual change view of learning and understanding. In L. H. T. West & A. L. Pines (Eds.), Cognitive structure and conceptual change (pp. 211-231). Orlando, FA: Academic Press.

Strike, K. A. & Posner, G. J. (1992). A revisionist theory of conceptual change. In R. A. Duschl & R. J. Hamilton (Eds.), Philosophy of science, cognitive psychology, and educational theory and practice (pp. 147-176). Albany, NY: State University of New York Press.

Thorley, N. R. (1990). The role of the conceptual change model in the interpretation classroom interactions. Unpublished doctoral thesis. University of Wisconsin-Madison.

Toulmin, S. (1972). Human understanding. vol.1: General introduction and Part I. Princeton, NJ: Princeton University Press

Vosniadou, S. & Ioannides, C. (1998). From conceptual development to science education: a psychological point of view. International Journal of Science Education, 20: 1213-1230.